**Assignment 5**

**CIS355** – Spring Term 2018

**Point Value**: 100 points

**Assignment Due Date**: **In class Thursday, April 19, 2018**

**Submission Instruction**

Please write the questions and your answers to those questions on a Microsoft Word document. The name of the file should be HW5\_YourLastname\_YourFirstname.docx. Please submit the file .docx on Schoology by 11:59pm and a hard copy of the .docx file to the instructor in lecture.

**Short answers**

1. What is virtual memory **(2 points)?** What is the purpose of virtual memory **(2 points)?** Where is the virtual memory stored? (**1 points**)
2. Under what circumstances do page faults occur **(5 points)?** Describe the actions taken by the OS when a page fault occurs. Please use 1, 2, 3, … to indicate the order of the actions taken by the OS. (**10 points**)
3. Considering the following page reference string:

7, 2, 3, 1, 2, 5, 3, 4, 6, 7, 7, 1, 0, 5, 4, 6, 2, 3, 0, 1

Assuming demand paging with three frames, how many page faults would occur for the following replacement algorithms

**LRU (10 points):**

**FIFO (10 points):**

**OPT: (10 points):**

1. In addition to LRU, there is a similar page replacement algorithm called Least Frequently Used (LFU). Under LFU, when the memory is full and a new page will be brought into memory, the page with the least reference frequency will be replaced. Describe a situation in which a least frequently used (LFU) page replacement algorithm generates fewer page faults than the least recently used (LRU) page replacement algorithm**? (10 points)**
2. A given system provides three frames to a program. The system uses single-layer paging (one page table) stored in memory but also has a TLB. TLB hit rates are 88%. Assume a TLB access takes 20ns, a memory access requires 200ns, and a page fault costs 8,000,000ns. Provide the amount of time a program with the reference string below spends accessing memory when using second chance FIFO. (**20 points**)

Reference String: 7, 0, 1, 2, 0, 3, 0, 4, 2, 3, 0, 3, 2, 1, 2, 0, 1, 7, 0, 1

1. Please explain what is a reference bit in the second chance algorithm? **(5 points)** What is the modified/dirty bit in the enhanced second chance algorithm? **(5 points)**
2. We use 5-bit logical addresses which allows 32 possible locations. The higher 3 bits are used for the page number and the lower 2 bits are used for the page offset. What is the size of a frame? **(5 points)** How many pages are in the page table? **(5 points)**